AIChE's Student Chapter Competition for 2008: Chem-E-Car Competition

Sponsored by General Mills

Based on *Rules Updated – September 8, 2008*

2008 Chem-E-Car Competition Timeline

Timeline	Date	Item
1		For regional competitions: Plan Chem-E-Car vehicle using approved safety procedures. A JSA form must be filled out and appropriate approvals obtained. Instructions will be provided.
2		Design, build & test car following approved safety procedures specified at each university and the national Chem-E-Car competition.
3	various dates	Regional Competitions. **Regional qualifiers must submit their entry on the website and send their $100 entry fee to AIChE National (Attn: Mr. Gordon Ellis) PRIOR to 30 June 2008, to secure their slot in the National Competition** Website open until 30 April 2008 FOR QUALIFIED REGIONAL WINNERS ONLY for the National Competition application submission. http://interact.hpcnet.org/sdsmtforms/aiche/register.htm
4		Revise and modify cars following approved safety procedures specified at each university and the national Chem-E-Car Competition.
5	1-May-08	Website opens for application submission **for any open slot**, and is open until 30 Jun 2008. No applications for open slots will be accepted prior to 1 May 2008 (Eastern Time) http://interact.hpcnet.org/sdsmtforms/aiche/register.htm
6	30 Jun 2008	Eligible team's Student Chapter Annual Report must be completed via web submission http://www.aiche-xtranet.org/aichereport/default.asp?CatID=2
7	30 Jun 2008	Closing date for submissions for regional qualifiers and any applications for open slots for the National Competition. Decision on number of open positions will be made and open-slot teams notified within 30 days.
8	2 Sep 2008	$100 entry fee due from teams selected for any open slots for the National Competition.
9	1 Oct 2008	Closing date for Web Application of Chemical Usage and JSA.
10	24 Oct 2008	All chemicals must be received by close of business at designated receiving location.

The objective of this competition is:

- To provide chemical engineering students with the opportunity to participate in a team-oriented hands-on design and construction of a small chemical powered model car.
- To design and construct a car that is powered with a chemical energy source that will carry a specified load over a given distance and stop.
- To encourage students to become actively involved in their professional society.
- To increase awareness of the chemical engineering discipline among the general public, industry leaders, educators and other students.

There are two general competitions. The first is held at spring regional conferences and the second is held at the AIChE Annual Meeting. Each year the annual competition is held in conjunction with the Annual Student Conference at the site of the AIChE Annual Meeting. A host AIChE chapter, along with the national AIChE staff and the competition sub-committee from the Student Chapters Committee, and SACHE, provides support for the annual competition.

There is a poster session and a distance or performance session at each competition, as detailed below. Each year the rules may be modified to address concerns that have developed at the past regional and annual competitions. The rules listed below have been significantly modified, so be sure to read all of them carefully.

Competitions

Regional Conference Competitions

1. In general, a school can have any number of entries at the Regional Conference. However, the Host School has the right to set a limit, should the need arise.
2. The rules listed under the National Conference Competition shall apply for the regional conference competition.
3. Regional conference host school organizers should contact the National Chem-E-Car Rules Committee (see below, after item 12) with questions or for clarification on the competition rules.

Regional Conference awards:

Poster Competition:

- Ribbons for 1st, 2nd, and 3rd place
- Ribbon for Most Creative Drive System
- Ribbon for Most Creative Vehicle Design

Performance Competition:

- 1st place: $200 and Ribbon
- 2nd place: $100 and Ribbon
- 3rd place: Honorable mention and Ribbon
- Ribbons for 4th and 5th place finishers
- Ribbon for Spirit of Competition

National Conference Competition
There will be a maximum of 31 car entries at the 2008 National Conference. The list of national entries is drawn from regional winners, based on the size of each region. Each Student Chapter Region may send their first and second place winners at the minimum. Mid-America, Northeast, Rocky Mountain and the Western regions may send their 1st, 2nd and 3rd place winners. The Mid-Atlantic, North Central, and the Southern Regions may send their top five winners. While multiple entries from a single school may be permitted at the regional competitions only one entry per school, via this qualifying procedure, is allowed at the national competition. Multiple entries per school may be allowed following the open entry procedure outlined in the following paragraph.

Submit your application online: The eligible teams from the Regional Conference Competitions (as described above) *must submit* an application to compete in the national competition at the 2008 AIChE Annual Meeting in Philadelphia, PA. Applications should be made by Web application starting immediately after their regional conference concludes and ending on June 30, 2008. If an eligible chapter does not submit their application by the above deadline their competition slot will be opened up to any ChE car team from any region that wishes to compete according to the following procedure. Interested teams who do not qualify at a regional competition should submit their application to the website given above beginning on 1 May 2008 but at least by June 30, 2008. On July 1, 2008, any open entry slots will be allocated on a "first come" basis; however, preference will be given so that there will be only one team entry per student chapter. For this year's national competition a $100 entrance fee will be charged for each competing team. This entry fee was added to cover the cost of the disposal of chemicals at the competition site. This entry fee must be paid to AIChE as given below:

Web application to Compete in Nationals (submit by 30 June 2008)
Applications should be made by Web application to compete in nationals-- **http://interact.hpcnet.org/sdsmtforms/aiche/register-online.htm** -- and should include:

- Student Chapter Name
- Point of contact for the team (name, phone number, email address)
- List of team members
- Title of entry
- General description of chemical reaction(s) / drive system (at least 1 or 2 paragraphs so the judges can understand any potential safety issues involved.)
- Regional Conference (and place) where the team competed
- Place earned in the regional performance competition, or indicate applying for open-slot
- National Competition Fee of $100. (See web for details)

Web Application: Chemical Usage (Deadline: 1 October 2008)

- Sign-up for safety training for 2008 (site?)
- List of chemicals (common name, IUPAC name, and Chemical Abstracts Service number [CAS number]) to be used and estimated quantity needed (see Rule 12 below)
- Completed Job Safety Analysis using required form (JSA)

Questions about the application process should be sent to:

Professor David Dixon
Dept. Chemical and Biological Engineering
South Dakota School of Mines and Technology
501 E. St. Joseph Street
Rapid City, SD 57701
Work Phone: (605) 394-1235, FAX (605) 394-1232
Email: david.dixon@sdsmt.edu

There are two sessions of the National Chem-E-Car Competition: a poster competition and a car performance competition.

Poster Competition

a. A poster board must be displayed with the autonomous vehicle on the day of the competition. This poster should describe how the car is powered using the chemical reaction, the unique features of the car, and environmental and safety features in the design. Appropriate documentation on the design and testing of your vehicle must be available for inspection by the judges at the poster competition. This documentation must include:

- vehicle design description and (drawings – are these necessary for all cars?)
- testing results
- Job Safety Analysis Form, given below
- Material Safety Data Sheets (MSDS) for each chemical used by the entry
- calculation of relief valve size and evidence of hydraulic pressure testing if required, see below
- procedures for transportation of vehicle and related accessories
- letter from student chapter advisor or department chair stating that to the best of his/her knowledge that the students abided by the rules.
- Entries will also be judged on creativity in the propulsion system and the appearance of the vehicle.

b. The poster competition and judging will occur prior to the Chem-E-Car Performance Competition. Team members should be present during judging to answer questions from the judges.

c. A team must achieve a minimum score of 70% in the poster competition to be able to advance to the Chem-E-Car Performance Competition. Posters will be judged according to the following criteria:

- Description of the chemical reaction / power source (20%)
- Design creativity and unique features of the vehicle (20%)
- Environmental and safety features (40%)
- Quality of the poster and team member presentations (20%)

d. Winners of the poster competition will be announced at the end of the performance competition:

- 1st, 2nd and 3rd place plaques will be awarded.
- A plaque will be awarded for Most Creative Drive System
- A Golden Tire plaque will be awarded for the Most Creative Vehicle Design
- Society of Biological Engineers Award for Best Use of a Biological Reaction to Power a Car
- SAChE Safety Award for the best application of the principles of chemical process safety to the Chem-E-Car competition.

Chem-E-Car Performance Competition:

1. Load and Distance:
Each car will be given two opportunities to traverse a specified distance carrying a certain additional load. The required load and distance will be given to each team one hour prior to the start of the performance competition. The distance will be between 15 and 30 m ± 0.0127 m (50 - 100 ft ± 0.5 in.) and the load will be between 0 and 500 ml of water. A judge from the student host chapter will measure out the prescribed water for each team. Teams may not add or remove any "load" (or other inert items) to adjust their vehicle weight once the poster session has concluded. Teams are allowed to adjust "fuel" or reactants used in the car's chemical reaction.

2. Course Layout and Distance Measurement:
The car will start with its front end just touching the designated starting line. There will be a designated finish line. The distance will be measured with respect to the front most point of the car. The goal of the competition is to have your car stop closest to the specified finish line (in bounds) while carrying the specified load. The course should be wedge-shaped with a starting line and the prescribed distance clearly marked in an arc of constant distance from the starting point. The physical site will dictate the exact course layout. See Figure 1 for an example of the course layout. A vehicle that goes outside the course will have its distance measured to where it went out of bounds, and a penalty of 3.048 m (10 feet) will be added to the measured distance. “Outside the course” is defined as having the entire vehicle outside the side tape boundaries of the course. The tape is considered as part of the course. When measuring the distance from the finish line it does not matter if the car goes longer or shorter than the prescribed distance.

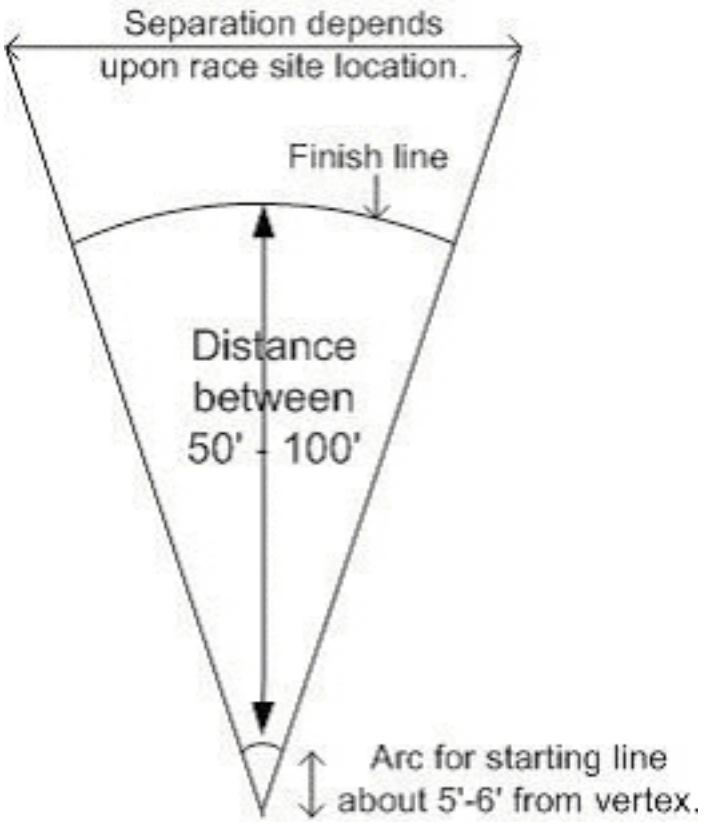

Figure 1. Sketch of typical performance course layout

3. Race Logistics:
A Chem-E-Car Competition judge (or MC) will announce each team just prior to the start of their run. Each team will be asked to introduce its entry to the audience, giving the school name and briefly mentioning the propulsion system. Each car will have two (2) attempts to complete the course, each attempt lasting no more than two (2) minutes. The best score of these two attempts will be used in the judging. In the event a team fails to show up on the starting line, or the vehicle fails to start, the next team in the order of the competition will be announced and requested to proceed to the starting line. The order of the teams in the first round of competition will be determined by random drawing. There will be a short break at the completion of the first round before the second round begins. The competition order in the second round will be determined by the 1st round standings, beginning with the team that is farthest from the prescribed distance and ending with the team that was closest.

4. Starting Procedure:
Each car is guaranteed a maximum competition time of two (2) minutes. The car must start moving, traverse the distance, and come to a stop within this time interval. If the car goes out of bounds, the next team must be ready to start its run as soon as the MC invites the team to the starting line. Since the run time of cars that go out of bounds or do not start may be less than two minutes, the next car in the order of the competition must always be ready to run at a moment's

notice. If a car does not stop within the 2-minute period, then it is disqualified from that round of the competition.

5. Competition Order Logistics:
The purpose of the time restrictions is to allow 31 cars to compete at the national competition within the period allotted for the event.

5.1. Team start order is determined during the poster competition.

5.2. The order for the first round may change because of disqualifications. If a car is disqualified that was scheduled to start before your car, then you will move-up one position in the start order earlier than was originally scheduled.

5.3. The load and distance are announced one hour before the competition starts.

5.4. Five (5) minutes before the start of the competition, the first three (3) teams are called to the start. The first team will be at the start line, the second team at ready, and the third team at the water load check station.

5.5. The first team is given a one-minute warning before the competition starts.

5.6. The competition starts when the MC signals the timing to begin. The first team is given 2 minutes for the car to start moving, traverse the distance and stop. When the car stops, the timer is reset for the next competitor. The timing will also stop if the car travels out of bounds. If the car does not stop within the 2-minute period, then it is disqualified from that round of the competition.

5.7. After the car for team 1 stops, the distance traveled is measured. During the distance measurement, team 4 is called and each team moves up one position. Team 1 should take their car directly to the chemical disposal station to dispose of their spent chemicals. This disposal process is repeated for each car upon completion of its run.

5.8. After the measurement is completed, team 2 is told to start their car, and has 2 minutes to complete the run. When the car stops, the timer is reset for the next competitor. The timing will also stop of the car travels out of bounds. If the car does not stop within the 2-minute period, then it is disqualified from that round of the competition.

5.9. During the distance measurement of team 2, team 5 is called and each team moves up one position. The process is continued until all qualified cars have competed once in the competition.

Note that if every car took two minutes to complete the course, then the competition for 31 cars would take a minimum of 124 minutes, which is more than the two hours allotted for the competition. To enable the competition to proceed in a timely fashion, it is recommended that the next team to compete should be ready and at the staging area at least five (5) minutes before

their anticipated run time. Upon the completion of the run of the previous team, the next car should be ready to start.

6. Vehicle Drive System:
An objective of this contest is a demonstration of the ability to control a chemical reaction. The only energy source for the propulsion of the car is a chemical reaction.

6.1. Vehicles entered into the competition must have a significant and demonstrable student design component, particularly with respect to the vehicle drive system, and the starting and stopping mechanisms. Any vehicle that is purchased from a vendor without major modifications to its operation will be disqualified. For example a team could not purchase a fuel cell car and race this car without any modifications. (e.g. Thames and Kosmos - Fuel Cell Kit -- http://www.thamesandkosmos.com/products/fc/fc2.html).

6.2. Commercial batteries: No commercial batteries (for example, AA batteries) are allowed as the power source. Commercial batteries are allowed for specialized instrumentation (e.g. detectors, sensors)

6.3. Autonomous vehicle: The car must be an autonomous vehicle and cannot be controlled remotely. Pushing to start the vehicle or using a mechanical starting device is not allowed. Check with the Rule Coordinators (see below, after item 12) if you have a specific question concerning your vehicle.

6.4. No brakes: No mechanical force can be applied to the wheel or ground to slow or stop the car (e.g. no brakes).

6.5. Mechanical or electronic timing devices: There can be no mechanical or electronic timing device(s) to stop the chemical reaction or stop the car. In addition, a timing device can not utilize what is normally considered as an instantaneous reaction. For example, a constant, or draining, liquid feed to a sensing cell that employs an instantaneous reaction (acid-base or precipitation) would not be allowed. Another example would be a liquid draining out of a vessel to serve as a stop switch would be considered a mechanical timing device, and would not be allowed.

7. SAFETY:

The safe preparation and operation of all vehicles during the competition is mandatory. During the poster competition, an audit team will inspect each vehicle to insure that all of the safety requirements have been completed and that the vehicle will operate without risk to the operators, contest staff and spectators.

All cars must safely operate inside a building. If the audit team deems the vehicle safe to operate, then the vehicle will be given permission to compete. This permission is not automatic and must

be earned using the guidelines / procedures outlined below. If a car is deemed unsafe, then it will not be given permission to compete. Vehicles that are not given permission to compete at the regionals cannot compete in the national competition unless they can demonstrate they have corrected the problems from the regional competition. The national safety audit team at the competition site has the final say in regard to permission to compete, regardless of whether a car was given permission to operate at the regionals.

There is no restriction on requesting assistance on vehicle safety – teams may request safety assistance from their faculty advisor, other faculty members, other universities, and professional practitioners in industry and elsewhere.

The primary method for characterizing the hazardous properties of chemicals for the ChemE car competition is by the National Fire Protection Association (NFPA) method. This method assigns a numerical value to the degree of hazard based on three major hazard groups: toxicity, flammability and instability / reactivity. The numerical values range from 0 to 4, with 0 representing the lowest degree of hazard and 4 representing the highest. See www.nfpa.org for more details on this.

An excellent source of information on the hazardous properties of chemicals is the National Institute for Occupational Safety and Health (NIOSH), www.cdc.gov/niosh. In particular, they support a free, on-line guide to chemical hazards call the *NIOSH Pocket Guide to Chemical Hazards*. This is available at http://www.cdc.gov/niosh/npg/default.html.

If there is an uncertainty on an issue of safety, contact the national rules coordinators: Professors Skip Rochefort, Robert Ofoli, or George Roberts – see contact information below under item 12.

7.1 Disallowed Vehicles: The following vehicles are disallowed:

7.1.1. No flames and/or smoke: All cars are restricted from having any open flames or emitting any smoke.

7.1.2. No internal flames: Cars shall not have internal flames. The only exception to this rule is the use of a commercial internal combustion engine that uses an alternative fuel that is synthesized by students. Succinct safety procedures for the maintenance and operation of this engine must be demonstrated by the team. In addition, use of an internal combustion engine must show a demonstrable and significant student design component.

7.1.3. No Liquid Discharge: Liquid may not be discharged under normal operating conditions. Liquid discharge is allowed during emergency relief situations to protect the equipment from rupture / explosion – this discharge must be collected in a containment vessel.

7.1.4. No Open and/or Improperly Secured Containers: All containers on the vehicle containing chemicals with an NFPA rating of 2 or greater must be

securely attached to the vehicle to prevent the container from tipping over during the competition. The lid to this container must also be securely attached to the container and must be capable to preventing escape of the chemical during any phase of the competition.

7.1.5. No Open Chemical Pouring at the Starting Line: No open pouring of chemicals with an NFPA rating of 2 or more is permitted at the starting line. It is suggested that a small holding tank with a valve or a syringe be added to the vehicle to add the chemical at the starting line. The chemical is added either by pushing on the syringe, or by gravity flow through the valve. All containers brought to the starting line with chemicals having an NFPA rating of 2 or more must be properly labeled, must have a lid to prevent spillage, and must be properly managed to prevent spillage.

7.1.6. No Regulated Chemicals: A number of chemicals are listed by OSHA as a special hazard. The handling of these chemicals is way beyond the management systems available during the Chem-E-Car Competition. OSHA has a special regulation for each chemical. See www.osha.gov for details. Because of the hazards involved no chemical listed as regulated by OSHA will be allowed on any vehicle participating in the competition.

Regulated chemicals include: asbestos, coal tar pitch volatiles, 4-nitrobiphenyl, alpha-napthylamine, methyl chloromethyl ether, 3,3'-dichlorobenzidine, bis-chloromethyl ether, beta-naphthylamine, benzidine, 4-aminodiphenyl, ethyleneimine, beta-propiolactone, 2-acetylaminofluorene, 4-dimethylaminoazo-benezene, n-nitrosodimethylamine, vinyl chloride, inorganic arsenic, benzene, 1,2-dibromo-3-chloropropane, acrylonitrile, ethylene oxide, formaldehyde, 4,4'-Methylenedianiline, 1,3-butadiene, methylene chloride.

7.1.7. No Highly Reactive / Unstable Chemicals: Any chemical, raw material, intermediate or product with an NFPA reactivity / instability rating of 4 is not allowed. According to www.nfpa.org, this represents "those materials that, in themselves, are readily capable of detonation, explosive decomposition, or explosive reaction at normal temperatures and pressures." This includes: acetyl peroxide, 3-bromopropyne, cumene hydroperoxide, di-tert-butyl-peroxide, diethyl peroxide, diisopropyl peroxydicarbonate, 0-dinitrobenzene, divinyl acetylene, ethyl nitrite, nitroglycerin, nitromethane, paracetic acid, and some high explosives.

7.2. Double / Redundant containment: Vessels containing fluids that have an NFPA rating of 2 or higher must have external redundant containment as a component of the vehicle to prevent spillage.

7.3. Wiring: All wiring and exposed electrical components must be electrically insulated or covered to prevent the possibility of electrical shock or ignition of any component of a vehicle. Alligator clips and twisted wires represent both an electrical shock hazard and an ignition source for flammable vapors / liquids and are not allowed. Use more robust electrical connectors such as banana plugs or binding posts.

7.4. Guards for fast moving parts: Guards must be present for fast moving parts and pinch points (meshing gears, belts, etc.).

7.5 Pressurized vessels and components: Pressurized vessels and vehicle components represent a significant explosion hazard due to the substantial energy contained in the pressure. Student teams must demonstrate through appropriate pressure measurements that the pressures during normal operations do not exceed equipment specifications. Teams cannot just assume that the pressures are low. Appropriate documentation must be available for the safety auditors to examine during the poster competition. The student team must also demonstrate that the proper safety systems have been installed to prevent an explosion.

7.5.1. Pressure Rating of Vessels and Equipment: Student teams must show through appropriate documentation or testing that any vessels and equipment are designed and rated for safe operation.

For all pressure equipment designs, there are two pressures that are important for the safe design of the equipment. The **maximum operating pressure** is the highest pressure within the process during normal operation. The maximum operating pressure must be estimated and measured by each team. The **maximum allowable working pressure (MAWP)** is the maximum gauge pressure permissible in a pressure vessel for a designated temperature. Vessel failure typically occurs at 4 to 5 times the MAWP, although significant deformation of the vessel or equipment might occur prior to failure. The MAWP is usually determined by the equipment manufacturer and is based on the mechanical strength of the materials and the geometry. For commercially purchased pressure vessels, the MAWP should be stamped somewhere on the vessel, or available from the equipment manufacturer.

The following guidelines should be used:

1. To provide a safety margin, the maximum operating pressure must not exceed 90% of the MAWP. Under no circumstances should the MAWP be exceeded during normal operation.
2. The maximum operating pressure can be exceeded during emergency relief, but cannot exceed 110% of the MAWP.

For initial design purposes the maximum operating pressure can be estimated from the stoichiometry – but the actual pressure must still be measured once the car is operational. For example, a proposed reaction, when operating the car with its heaviest load

(500 grams water) and longest distance (100 ft), can create up 200 psig using the ideal gas law, and assuming complete reaction.

Student teams must also be aware that the maximum operating pressure is dependent on the amount of reactant(s) charged. Students must demonstrate that proper management systems and controls are in place to insure that the proper quantity of reactant is charged to the vehicle.

If the vessels / equipment are commercially produced, then the equipment manufacturer's technical specifications are adequate. If no rating exists, or if the vessel / equipment is old or shows wear, then hydraulic testing is required. Hydraulic testing is done using ONLY water at 1.5 times the maximum operating pressure for 30 minutes. No evidence for vessel or equipment swelling or leakage should be seen during this period.

The manufacturer recommendations for the use of all pressurized components, **especially plastic components**, for a vehicle must be thoroughly researched and documented. This includes following manufacturer's recommendations for use of materials. **The use of PVC, cPVC or polyethylene terephthalate (PETE or PET) for pressurized gases is prohibited in this competition.** All of these three types of plastics have microscopic defects that result in hoop stress failure. If other types of plastic components are used for pressurized gases such as ABS (Acrylonitrile-Butadiene-Styrene), Nylon, or Teflon (PTFE), then the manufacturer's specifications should be consulted as well as evidence of proper/adequate hydraulic testing be conducted. [CAUTION: Some teams in the past have had soda bottles (PETE), or PVC vessels explode when pressurized with a reaction that creates a gas! Please note that PVC is only rated by ASTM D 1785 – 05 as schedule 40 for water at temperatures less than 73°F and is not recommended for use with pressurized gases.]

7.5.2. Pressure gauge: All vessels and equipment with pressures greater than 1 psig must have a pressure gauge that reads from 0 psig to 2 times the maximum operating pressure. For the example in 7.5.1, the appropriate pressure gauge range is 0 to 400 psig.

7.5.3. Emergency Relief Device: All vehicles with pressures greater than 1 psig must have an industry standard relief valve that is appropriately sized, and is set at no more than 1.1 times the maximum operating pressure. The maximum operating pressure is typically defined as the pressure that would need to be generated to propel the vehicle 100 ft. and carry a load of 500 ml. For the example given in 7.5.1, the set pressure of the relief valve (the

point when the relief valve begins to open) is a maximum of 220 psig. This valve must be tested and evidence must be provided in the safety documentation. Size the relief devices per Crowl and Louvar, "Chemical Process Safety", Prentice Hall PTR, Upper Saddle River, NJ, 2002, or equivalent (See also the SACHE module: *Emergency Relief system Design for Single and Two-Phase Flow*, 2nd Ed. by Ron Darby. This can be downloaded by SACHE members at http://www.sache.org. Ask your AIChE faculty advisor for this manual and Excel spreadsheets.)

The design scenario for the emergency relief device must be clearly stated. For example, state the amount of reacting material assumed, the concentration of reacting material, the initial temperature, and any consideration of operating error such as overcharge, use of wrong material, or wrong concentration, and, if so, what is the "design case" error, etc? Also, the emergency relief system calculations must be included in the documentation and they must be reviewed and approved by a faculty representative.

7.6 Job Safety Analysis (JSA) Documentation: Each team will prepare and post a Job Safety Analysis on the poster board whenever the car is entered into competition. When preparing this JSA, the students should focus on identifying and explaining how the hazards will be eliminated or reduced to an acceptable level. The required Job Safety Analysis form is available here: http://www.aiche.org/uploadedFiles/Students/Conferences/07_ChECar_JSA_Ver7.doc

7.7. Safety Documentation:
Each team will prepare and have available safety related documentation for their vehicles. This documentation must include the JSA, calculations, experimental test results related to the safe operation of their vehicle. In addition, this documentation must demonstrate that the university has overseen the design, fabrication, testing and modification of the car. Documentation showing that these procedures have been followed must be properly dated and signed by appropriate faculty and students. If appropriate documentation is not provided at the poster competition, then the vehicle may not be issued permission to compete.

7.8. MSDS:
Each team must have a MSDS for each chemical it is using and for each product and intermediate during the reaction.

7.9. Personal Protective Equipment:
Appropriate personal protection (particularly safety glasses and gloves) must be worn by those team members during the preparation and operation of the vehicle.

7.10. Accidents / Incidents:
If there is a safety incident that occurs during the competition, then the AIChE student chapter advisor of that team will be informed that an incident analysis

report must be submitted to the head of the Chem-E-Car Student Chapters Subcommittee, David Dixon (address and contact info above). This safety incident report must be approved by the Chem-E-Car Student Chapters Subcommittee before any team from that university can compete in Regional or National Chem-E-Car Competitions.

8. Transportation of Vehicle and Chemicals:

8.1 Transportation of Vehicle:

Students are responsible for transportation or shipping of their vehicles to the competition sites. If shipping the vehicle, they must be received by the close of business on the Wednesday before the competition. Provisions by the student team must be made to restore their car to a state that is approved for transportation to and from their university for each competition. Check this website for more details on shipping to the national competition. For regional competitions, contact the host school for more information.

8.2. Chemical Shipment and Usage:

Teams are expected to follow DOT regulations in the transportation of any chemicals. For the national competition the team is required to ship the minimum amount of material to the competition. For example it is suggested to ship no more material than what is required for 5 runs. **Chemicals must only be shipped to the designated holding facility that will be specified by the Host Chapter of the Chem-E-Car Competition**. **All chemicals must be received at the designated holding facility 21 days before the Chem-E-Car Competition**. For this years competition the chemicals must be received by Friday, 24 October 2008. Chemicals can not be stored in hotel rooms. Contact the host chapter or check this website for the latest information on where chemicals may be stored at the national competition site. For regional competitions, the host chapter will designate rules for the proper shipping and receiving of chemicals. In all cases of both national and regional competitions Department of Transportation rules must be followed.

In order to facilitate the safe use of chemicals at the competition site, a designated area will be identified where teams must mix or prepare their chemicals (unless the material was shipped pre-mixed). All chemicals will be made available to the teams in the chemical preparation area at least 2 hours prior to the performance competition. Unfortunately, due to hotel/convention center safety regulations it is not possible to allow teams to do "trial runs". Teams that violate these safety rules jeopardize the continued operation of the Chem-E-Car Competition and may be disqualified by the judges.

Certain other basic chemicals and materials may be available onsite. At the competition, chemical waste disposal will be provided by the host chapter.

Student teams are responsible for entering on the web form a COMPLETE list of the chemicals they plan to use, no later than 1 October (for the national competition). Past host chapters have made arrangements with local chemical supply firms or local chemistry department stockrooms for procuring and/or disposing chemicals. Hazardous chemical protocols must be followed and reported on the poster.

(2008 National Competition shipping instructions --
To become available in September 2008)

9. Size of Car:
All components of the car must fit into a shoebox of dimensions no larger than 40 cm x 30 cm x 18 cm. The car may be disassembled to meet this requirement. If the judges are uncertain whether the car will fit inside the box when dissembled, they may request that the team demonstrate that they can do this.

10. Water Load Container:
The car must carry a container that holds up to 500 mL of water without spilling. An example container is a Nalgene Low-Density Polyethylene Narrow-Mouth Bottles (500 mL) Nalge No. 38-430 20039016 or Fisher Cat. No 02-923-11G. At the competition, only the water will be supplied, thus each car must already have its own container.

11. Capital Cost of Vehicle:
The cost of the contents of the "shoe box" and the chemicals must not exceed $2000. The vehicle cost of the car includes the donated cost of any equipment. The time donated by university machine shops and other personnel will not be included in the total price of the car. It is expected that every university has equal access to these resources. The cost of pressure testing is also not included in the capital cost of the car. The method used to estimate the donated cost of the equipment must be shown. It is expected that standard financial procedures will be used to estimate this cost. **The same car can not be reused from year to year**. Substantial changes should be made and indicated in the poster presentation.

12. Team Member Status and Conduct:

12.1. All team members attending the National Competition must be National AIChE members.

12.2. The competition will be conducted on the honor system. Faculty and graduate students can only act as sounding boards to the student queries. The faculty cannot be idea generators for the project. There is no restriction on requesting assistance on vehicle safety – teams may request safety assistance from their faculty advisor, other faculty members, other universities, and professional practitioners in industry and elsewhere.

12.3. The students working on the project must sign a statement saying they have read, understand, and abided by the rules. This statement must be included (or be available) at the poster competition.

12.4. This is a team competition and must have students from at least two chemical engineering classes. The percentage of students from any one class must not be greater than 80% of the total number of students on the team. Multi-disciplinary teams are also encouraged.

12.5. The minimum team size is five (5) participants. All team members do not have to be present at the National Chem-E-Car Competition; however, all are encouraged to attend, if possible.

12.6. Each Chem-E-Car team must have a faculty member and student team member that has undergone AIChE approved safety training.

12.7 All Chem-E-Car team members must have received appropriate safety training by the university.

12.8 All student chapters that are competing in the national competition must have submitted a Student Chapters Annual Report online to AIChE following the standard timelines given by AIChE.

If there is any uncertainty on an issue of safety or other judging criteria, please contact:

Rules Coordinators: (Contact these folks first if you have questions on the rules.)

Dr. Skip Rochefort	Dr. Robert Ofoli	Dr. George Roberts
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rochefsk@engr.orst.edu		groberts@eos.ncsu.edu

13. Declaration of the Winning Team:

The winning team is the car that stops closest to the finish line. This is defined as the absolute value of the distance between the front most part of the car and the finish line. In case of ties, the team with the best average from the two runs will be declared the winner.

Winners of the National Chem-E-Car Performance Competition will be recognized immediately following the performance competition. General Mills sponsors the National Chem-E-Car Competition. The National awards are:

- 1st place: $2000 and a trophy
- 2nd place: $1000 and a trophy
- 3rd place: $500 and a trophy

In addition to the top three performance awards, other awards will be given as described below:

- **Best Use of a Biological Reaction to Power a Car - $1,000 Prize:** Sponsored by the Society for Biological Engineering
- **SAChE Safety Award** for the best application of the principles of chemical process safety to the Chem-E-Car competition.
- **Most Consistent Performance** - This award is based on the best average score for the two runs that the vehicle makes. It has been created to recognize the team that has designed and most understands the performance of the reaction that powers the vehicle. Award consists of a plaque.
- **Spirit of the Competition** - This award is given to the team displaying the most team spirit as decided by a panel of judges. Award consists of a plaque.
- **Most Creative Drive System** - Recognition is awarded to the team that has designed and installed the most creative propulsion system. The winner is decided by a panel of judges during the poster competition. Award consists of a plaque.
- **Golden Tire Award** - In 2002, Northeastern University team members created this award to recognize the team with the most creative vehicle design. The national committee has adopted this as an annual award. The winning entry is decided by a ballot cast by each team entered in the competition. Award consists of a plaque.

For more information on this competition, contact AIChE at (646) 495-1348, studentchapters@aiche.org, or by fax at (646) 495-1504.

This document was prepared and revised by a subcommittee of the Student Chapters Committee with members Sid Sapakie, H. Scott Fogler, Robert P. Hesketh, Dick Zollars, Chuck Coronella, Robert Ofoli, George Roberts, Skip Rochefort, Jim Smith, Scott Berger, and Dave Dixon, chair. In addition, the Chem-E-Car Subcommittee of SAChE contributed the Job Safety Analysis Form and additional rules to ensure the safe operation of all cars. The SACHE subcommittee was chaired by Joe Louvar with members Dennis Hendershot, Dan Crowl, Bob Rosen, and Ron Willey.